REMARKS

Remarks below are numbered in to correspond to numbering in the office action.

Information Disclosure Statement

1. Applicants filed a two-page Electronic Information Disclosure Statement (EIDS) citing twelve (12) references, and a copy of this EIDS, stamped with applicants' 11/8/2002 filing date, was included in the office action papers with all references initialed by examiner.

Since this EIDS is a suitable "separate paper" in a form prescribed by the patent office and all references on this EIDS have been initialed, applicants presume that these references have been considered, even if not listed on examiner's PTO-892. All of the references "incorporated into the specification" were included in this EIDS and so were properly disclosed in a proper information disclosure.

Applicants hereby requests confirmation that this is in fact the case.

Specification

2. The amended abstract is now less than 150 words.

3. All of the suggested changes have been made.

Drawings

4. The attached replacement sheets for Figures 19, 21, and 22

fully address the drawing objections, as discussed above.

Claim Objections

5. All changes suggested by examiner have been made, with the exception of the following (line numbers refer to those used by examiner, not necessarily the line number in this document):

Claim 38, line 9 and line 10, "said voltage" was unchanged. Claim 2, upon which claim 38 depends, provides proper antecedent basis.

Claim 48, line 7, there is already a comma in this location following the equation.

Additionally, claims 28-31 and 88-91 are corrected to changed the superscript associated with meters from cubed to squared. This was a typographical error in the claims as filed.

Claim Rejections - 35 USC § 112

6. In reply to examiner's rejection, claim 1 has been amended to separate the ionic preconcentration cell from the data associated with that cell, such that these are presented as a system comprising both the cell and the associated data. This obviates any clarity question which might be raises in terms of how a cell itself might "comprise" data. Of course, this does not preclude the possibility that the cell might contain an embedded computerized device containing that data, nor does this require it.

The data element of this system is also amended to recite "calibration data associated with said cell characterizing

a response from said cell when said cell or an equivalent cell is exposed to x-rays under calibration conditions, used in combination with test data characterizing a response from said cell when said cell is exposed to x-rays under test conditions, to deduce an identity, or measurement of concentration, of at least one element in said fluid."

This clearly sets forth "how the data is obtained" (exposing the cell to x-rays under calibration conditions), and the "structural and functional relationship between the data and the other claimed aspects of the invention" (cell and data each part of the system, calibration data used in combination with test data to identify and measure concentration of elements in the fluid.) "Means for obtaining data" are clearly recited (response from exposure to x-rays under calibration and test conditions).

As such, these 112 rejections are overcome.

7. In claims 17 and 77, the trademark "Delrin® plastic" is replaced with the phrase "a non-conducting, machinable polymer substantially resistant to radiation degradation," which is generically-descriptive of Delrin®.

Claims 17 and 77 are also amended to depend on claims 4 and 64, and to further specify the nature of the body itself in relation to the electrodes and the upper x-ray transmission window. The reasons for amending these and several other claims in this manner are discussed in detail in point 17, below.

In claims 26, 27, 86 and 87, the trademark "Kapton®" is replaced with the phrase "a polyimid film comprising structural

rigidity to support up to 1/10 atm. of pressure without bowing more than approximately 100 microns," which is generically-descriptive of Kapton®.

8. In reply to examiner's rejection, the word "second" has been removed from claims 38 and 98, and further amendments have been made to address the antecedent basis issue referred to by the examiner. The dependency of these claims should remain as it was at the time of filing, i.e., claim 38 continues to depend upon claim 2 and claim 97 continues to depend upon claim 62.

9. In reply to examiner's rejection, claim 62 now recites the steps of "exposing said cell to x-rays under test conditions and obtaining test data characterizing a response thereto of said cell; and deducing an identity, or measurement of concentration, of at least one element in said fluid, using said test data in combination with calibration data associated with said cell characterizing a response from said cell when said cell or an equivalent cell is exposed to x-rays under calibration conditions."

This clearly links together all of applicants' steps leading to deducing a concentration, and so overcomes this rejection.

Claim Rejections - 35 USC § 102

10. Before responding to the office action on a point-by-point basis with regards to particular claims, it is important to outline the fundamental differences between what is disclosed,

suggested and motivated by Tran, and what is taught by applicants.

Fundamentally, Tran's patent is about the *removal* of ions from solutions in order to purify those solutions. This is very different from the crux of what applicants teach, which is *identifying* ions in solution, i.e., determining what particular element or elements are in the solution, and *measuring the concentration* of ions in solution, i.e., determining the "parts per" level at which a particular identified element is present in solution. What is also very significant about applicants' disclosure is the *sensitivity* it achieves. Applicants are able to measure ionic concentration in the *parts per billion* range, which is beyond the reach of present technology, and, in reaching into the parts per billion range, applicants have discovered certain important mathematical approximations which can be applied to calculating concentration, in these extremely-dilute ranges.

Because Tran's fundamental motivation is to *remove ions from solutions to purify those solutions*, certain considerations will be important to Tran, while other considerations will be unimportant or perhaps even counterproductive. Thus, for example, it is important to Tran to provide a relatively large quantity of porous electrode material, because the more material that is provided, the more ions can be removed before regeneration is required. Similarly, it is important to Tran to remove close to 100% of the ions, since removal and purification is Tran's fundamental motivation. Using a very small amount of

electrode material, or removing only, say 1% of the ions from solution, would not only be unimportant to Tran, but it would defeat the purpose of what Tran is trying to do, namely, remove as much ionic content from solution as possible in the shortest period of time.

In contrast, because applicants' fundamental motivation is to *identify what ions are in solution and measure their concentration with extremely high sensitivity and repeatability* in the parts-per-billion range, a different set of considerations will be important to applicants. Some considerations which are important to Tran will be unimportant or even counterproductive to applicants. Thus, for example, applicants find it important to only remove a small percentage of the ions from solution - in the 1% to at most 5% range - because removal of a low percentage of ions yield the most accurate measurements of concentration. Were applicants to remove close to 100% of the ions as Tran is motivated to do, applicants would be defeated from achieving their fundamental purpose, namely, to accurately identify the elements present in solution, and precisely measure their concentrations. Similarly, applicants' motivation is better achieved with a very small cell which removes very few ions, rather than a large cell removing large numbers of ions.

Because of these divergent motivations, the approaches and techniques employed in Tran will necessarily differ from the approaches and techniques employed by applicants. Importantly, from the standpoint of patentability under 35 U.S.C. 102 or 103, the only inventive means or steps which are disclosed or

suggested by Tran are those inventive means or steps which are motivated by Tran, that is, *those means or steps which aid in the removal of ions from solution*. Conversely, means or steps disclosed by applicants which are *not motivated* by Tran (i.e., which are not necessary for ionic removal), and especially means or steps which would defeat the purpose of Tran were they to be employed by Tran (i.e., which would stand in the way of ionic removal), cannot by any stretch be said to be disclosed or suggested by Tran.

Thus, at a fundamental level, it is important in assessing applicants' claims in relation to Tran to keep clearly in mind at all times, which means or steps serve to facilitate removal of ions as motivated by Tran but may have nothing to do with or even be counterproductive to applicants' ionic identification and concentration measurement, and which means and steps serve to facilitate identification and concentration measurement of ions as motivated by applicants but may have nothing to do with or even be counterproductive to Tran's ionic removal.

Starting with these divergent motivations, a first important point of departure between Tran and applicants revolves around regeneration cycles. Because Tran's motivation is ionic removal, and because Tran cannot provide an infinite quantity of porous electrode material to absorb ionic contaminants, Tran will necessarily remove ionic material as quickly as possible until the cells (or certain electrodes in a cell) become saturated. Once the cells (or electrodes) reach saturation - assuming that there is still more fluid to be purified - Tran will also

necessarily have to detect that saturation has been reached, stop the removal phase, and regenerate the cell (or electrodes) by purging the accumulated ions into some waste stream other than (for obvious reasons) the fluid being purified. Once the cell is purged, Tran then starts up a new removal cycle. Such iteration between removal and regeneration continues until all the fluid at hand is properly purified.

Thus, a very significant part of Tran's disclosure centers around managing this iterative removal and regeneration cycle. To manage this iterative cycle, it does become necessary to detect when saturation has been reached, and then to take some action based on this - namely, initiating the regeneration cycle. Tran discusses this in depth, particularly at column 15, line 64 through column 16, line 42, and it is very important to understand what this discussion in Tran is - and is not - about.

In this discussion at column 15, line 64 through column 16, line 42, Tran provides various sensors such as conductivity sensor **145** to determine when a predetermined saturation level (referred to in Tran as "targeted breakthrough") has been reached. When Tran talks in column 15, lines 64-67 about monitoring the purified feed solution "until a targeted breakthrough is detected by the sensors," Tran is talking about *detecting saturation* so that the removal can be stopped and regeneration initiated. The term "targeted breakthrough" as used by Tran is another way of saying "predetermined saturation point," and in many places throughout Tran, it is very important to recognize that the word "detecting" really means "detecting

saturation."

In contrast, the word "detecting" as predominantly used in Tran does *not* mean "*identifying* which elements are in the solution." Nor does the word "detecting" as predominantly used in Tran mean "*measuring* a parts-per concentration of the elements in solution." "Detecting saturation," which is what Tran discloses, really *tells us nothing about the solution itself or the ions which that solution contains.* It tells us nothing about how to engage in precise measurement, e.g., determining a parts-per-billion number. It tells us nothing about identifying what particular elements are causing the saturation, and optimizing the cell configuration toward identifying the presence of and measuring the precise concentration of particular types of elements under particular flow conditions.

Rather, Tran's detecting "targeted breakthrough" *tells us only about the state of the cell itself*, namely, that the cell has reached a point where it is so full of ions that it can no longer absorb any more ions and will need to be purged before any more ions can be removed from the solution being purified. Tran needs to find out *information about the state of the cell;* applicants' whole motivation is to find out *information about the state of the solution.* Tran needs to know simply that the cell is saturated. Knowledge that 65% of the saturation is due to mercury concentrated in solution at 25 parts per billion and 35% of the saturation is due to arsenic concentrated in the solution at 8 parts per billion is irrelevant to Tran. The fact that the cell is saturated, and that regeneration needs to begin because

otherwise nothing else can be removed, is all that Tran cares about. To applicants, determining that mercury is concentrated in solution at 25 parts per billion and arsenic is concentrated in the solution at 8 parts per billion is the central motivation.

In sum, it is as if Tran can detect that a pipe is clogged by detecting that water is backed up, but Tran cannot determine the particulars of what substances are causing the clog, and cannot determine the concentrations of each of these substances causing the clog. Applicants, on the other hand, can determine this accurately and precisely. This is where any type of "detection" taught by Tran diverges from the identification and measurement taught by applicants.

Removing ions from solution, managing the regeneration cycle, and detecting saturation as part of this management as discussed above, are the only things that Tran discloses all the way through column 32, line 44, with the exception, perhaps, of column 16, lines 23-27.

At column 16, lines 23-27, Tran states: "Direct placement of radiation (or other aforementioned) sensors on cell (**30**) can also enable the accumulation of contaminants to volumetric concentrations above their respective detection limits, thereby enabling detection. In this application, the process is referred to as "electrochemical intensification" of the detected signal." This appears to introduce Tran's later disclosure starting at column 32, lines 45-53, that "[t]he teachings described herein, particularly as to the chromatograph columns, can also be used to design an electrochemical intensifier or concentrator. An

electrochemical intensifier is a device used to concentrate dilute ionic solutions for subsequent measurement by any of a variety of analytical techniques, such as ion chromatography, ion selective electrodes, differential pulse polarography." Further, Tran appears to disclose at column 32, line 66 through column 33, line 5 that "[t]he species that are present in the dilute solution at levels below the detection limit of a particular analytical technique can be concentrated to a level where they become detectable. If the ions are radioactive, they can be measured as they accumulate on the porous electrodes. Similarly, X-ray fluorescence can be used to monitor heavy metals, or like materials, that accumulate on the electrodes."

In short, beyond extensive disclosures pertaining to ion removal, management of the removal / regeneration cycle, and detection of saturation as part of this management effort, Tran does appear to disclose that an electrochemical cell can be used to concentrate dilute ionic solutions for subsequent measurement, and that XRF is among the techniques that that can be used for this measurement. But, very importantly, *Tran's disclosure goes not one step farther than this!*

First, in particular, Tran does *not* disclose or suggest *how* to carry out such a measurement in a precise way, that is, *how to ascertain that a particular element exists in the solution at "x" parts per billion.* Trans speculates that - in theory - one could use an ionic removal cell to measure concentration, but does none of the heavy lifting to teach or suggest *how* this might be done in practice.

Second, Tran also does *not* disclose or suggest *how to identify what that particular element is*, i.e., how to determine whether the element detected is, e.g., arsenic, or some other element such as lead or mercury. For example, when conducting XRF analysis, there is a good chance of confusion between the L alpha 1 lines and the lower energy K lines for elements with Z = 15 to Z = 40. The K alpha lines for Z = 15, 16, 17, 19, 20, 21, 22, 23, 24, 25, 31, 32, 33, 34, 35, 39, 40, 47, 48, 49, 50 can easily be confused with the L alpha 1 lines for Z = 73, 74, 78, 79, 80, 82. The EPA list of dissolved metals includes many of these elements. Tran does nothing to disclose *how* to achieve an accurate identification of elements, in practice.

Third, Tran also does not disclose or suggest how to *optimize* the configuration of an electrochemical cell toward the identification and measurement of a particular element or range of elements under a particular set of flow conditions. A larger cell with a large amount of porous electrode material is a good candidate for a removal cell. But, it turns out to be a terrible candidate for an identification and concentration measurement cell. A very small cell with a tightly-defined window for x-ray transmission and a flow rate and voltage selected to remove less than 5% of the ions from solution is an ideal candidate for identification and concentration measurement, but it is a terrible candidate for removing large amounts of ions to purify a solution. The thickness of the electrodes is also important, and, depending upon which element the cell will be used to identify and measure, some thicknesses are clearly more optimal

than others. Similarly for the interelectrode gap. The point is that once the motivation is applicants' identification and concentration measurement rather than Tran's removal, the whole design of the cell is implicated, because a cell which is optimized for Trans' motivation will be suboptimal, and even useless, for applicants' motivation, and vice-versa. Tran talks in theory about using a cell to concentrate dilute ionic solutions for subsequent measurement, and about XRF being among the techniques that that can be used for this measurement. But Tran offers not a single hint about how to optimize cell design for this purpose, does not at all disclose or suggest that the design of such a cell will be very different in a number of important ways, and certainly does not disclose or suggest the specific ways in which this design will be different.

A fundamental cornerstone underlying 35 U.S.C. 112 of the patent laws requires *teaching of how one proposes to implement an invention*, not merely an unsupported assertion that something can be done without providing any details about *how* to do so. Tran asserts that a cell can be used for concentration and subsequent XRF measurement, but provides absolutely no guidance about *how* to implement this assertion. Applicants, following several years of careful research and experimental testing, have disclosed at length, the novel and nonobvious details of *how to actually do this*, and this advances the state of the art well beyond anything disclosed, suggested, or motivated by Tran.

With this background, we now turn to the specific prior art claim rejections.

11. Examiner rejects claims 1, 2 and 62. Column 33, lines 3-4 and column 16, lines 23-27 of Tran, in particular, are said to anticipate applicants' "data associated with said cell."

Tran, in column 33, lines 3-4, recited earlier, states: "X-ray fluorescence can be used to monitor heavy metals . . ." Column 16, lines 23-27, states: "Direct placement of radiation (or other aforementioned) sensors on cell (**30**) can also enable the accumulation of contaminants to volumetric concentrations above their respective detection limits, thereby enabling detection. In this application, the process is referred to as 'electrochemical intensification' of the detected signal."

As stated earlier, the above excerpts from Tran do appear to disclose that an electrochemical cell can be used to concentrate dilute ionic solutions for subsequent measurement, and that XRF is among the techniques that that can be used for this measurement, in theory. However, *Tran's disclosure goes not one step farther than this.* Applicants disclose many of the details which Tran does not teach or suggest, regarding *how* to concentrate and measure ions. The development of calibration data is the first of the many novel and nonobvious means and methods for enabling what Tran only states is possible in theory, but does not teach or suggest how to do in practice.

While examiner has rejected claims 1, 2, and 62 as filed, examiner has also, in point 34, allowed claims 36-40 and 96-100 which provide further elaboration regarding the "data associated with said cell." Thus, examiner also appears to recognize the

novelty and nonobviousness of applicants' calibration data as a basis for identifying and measuring the concentration of elements in fluids. Therefore, in amending claims 1 and 62, applicants have sought to extract the underlying basis for the recitations of claims 36-40 and 96-100, and incorporate these recitations into claims 1 and 62.

Toward this end, claim 1 is now amended to recite: "calibration data associated with said cell characterizing a response from said cell when said cell or an equivalent cell is exposed to x-rays under calibration conditions, used in combination with test data characterizing a response from said cell when said cell is exposed to x-rays under test conditions, to deduce an identity, or measurement of concentration, of at least one element in said fluid."

Similarly toward this end, claim 62 is amended to recite: "exposing said cell to x-rays under test conditions and obtaining test data characterizing a response thereto of said cell; and deducing an identity, or measurement of concentration, of at least one element in said fluid, using said test data in combination with calibration data associated with said cell characterizing a response from said cell when said cell or an equivalent cell is exposed to x-rays under calibration conditions."

The key point of all of this, which is disclosed at length in paragraphs 97 through 110 of applicants' disclosure, and already claimed in more specific terms by claims 36-40 and 96-100, is that it is important, first, to have available

calibration data obtained by subjecting the cell to x-ray bombardment and XRF analysis under a *known*, controlled set of conditions, and second, when using the cell to "test" a fluidic sample of *unknown* composition, to compare the test data obtained to this calibration data (to use the test data "in combination with" the calibration data) to deduce "an identity, or measurement of concentration, of at least one element in said fluid."

In simpler terms, without knowing the XRF response of the cell or a similar cell under known, controlled conditions, it will not be possible to analyze the response of the cell under unknown conditions. Thus, in simplified terms, the calibration data is "subtracted away" from the test data to leave a true identification and measurement of concentration of the elements in the fluid.

Clearly, there is nothing in Tran which discloses or suggests the use of test data in combination with calibration data to yield an element identification and concentration measurement as set forth in applicants' claims 1 and 62. Consequently, applicants respectfully request allowance of claims 1 and 62 at this time, and, because all 35 U.S.C. 112 rejections have already been addressed, allowance of all claims dependent on claims 1 and 62, by virtue of their dependence.

Please observe that even in unamended form, that is, even in specifying merely "data associated with said cell enabling a concentration of at least one element in said fluid to be deduced" (claim 1) or "deducing a concentration of at least one

element in said fluid, using data associated with said cell." (claims 62) as originally filed, claims 1 and 62 already distinguished past Tran, because Tran does not disclose or suggest anything about how to deduce this concentration, or about the importance of data associated with the cell as the basis for deducing this concentration. Thus, applicants have entered these amendments (and many other amendments set forth below) simply to expedite prosecution, and without prejudice to the prosecutions of any later application based on this application.

Applicants have also amended previously-allowable claims 36-39 and 96-99 to emphasize that the data detailed in those claims are specific types of "calibration data" as set forth in claims 1 and 62. Applicants have also amended previously-allowable claims 40, 42, 100 and 102 to emphasize that the "test data" set forth in these claims is the same data as the "test data" recited in claims 1 and 62. This links amended claims 1 and 62 more tightly with these allowed dependent claims.

12. The utilization of an x-ray transmission window in intimate contact with the electrodes is another of the novel and nonobvious means and methods taught by applicants enabling an ionic cell to identify and measure the concentration of elements in fluids.

Examiner states that, "[r]egarding claims 4, 5, 64, and 65, Tran et al. further discloses upper and lower transmission windows in intimate contact with the electrodes (Fig. 29, #603 and 605)."

In making this assertion, examiner is equating applicants' upper and lower "transmission windows" with Tran's "plates" 603 and 605, and is further assuming that these plates are in "intimate contact" with the electrodes as specified by applicants' claims 4, 5, 64, and 65.

Applicants' transmission windows, as clearly set forth throughout the disclosure, are designed to transmit x-rays therethrough with a high signal to noise ratio, see, e.g., paragraph 80. Clearly, any type of metallic material - which is what Tran clearly discloses as its "plates" - will not properly transmit x-rays. That is, Tran's plates are not x-ray transmissive by any stretch of the imagination.

Tran, at column 32, lines 29-32, describes these plates 603 and 605 referred to by examiner: "Cell **600** generally includes two oppositely disposed, substantially flat plates or substrates **603, 605** that are *separated by an insulation layer* **606** of a predetermined thickness." This insulating layer 606 is thus necessary not to electrically isolate the two oppositely charged electrodes from each other, but *rather to electrically isolate the two serpentine channel-forming plates from each other.* Clearly, the only reason that insulation is necessary, is because these plates are made of a metallic material which is electrically conducting and opaque to x-rays. Had these plates been made of non-conducting material, insulating layer 606 would not be necessary at all. Thus, Tran's plates 603 and 605 are not "transmission windows" as defined in applicants' disclosure, because, being made of an electrically-conductive material,

Tran's plates will not properly transmit x-rays.

While the metallic, non-x-ray-transparent nature of Tran's "plates" can thus be easily inferred from column 32, lines 29-32, there are may other places in Tran where these plates are disclosed and where their properties and composition are explicitly discussed and established even beyond inference.

Thus, in column 12, lines 56-59, Trans states: "In a preferred embodiment, the end plates **31** and **32** are identical, rectangularly shaped, and made of 316 *stainless steel or another appropriate corrosion resistant alloy.*" Such plates could not serve as "transmission windows" as defined by applicants, since they would not transmit x-rays.

In column 25, lines 25-33, Trans states: "Cell **460** is mainly formed of two outer *conductive plates* **462, 463** connected to a D.C. power source. Two beds **465, 466** of a powdered or granular electrosorption medium selected from the above group, as well as activated carbon powder and various metallic powders, are retained against their corresponding plates **465, 466** [sic] by means of two porous or conductive membranes **468, 469,** respectively. A channel **470** is formed centrally between membranes **468, 469** . . ." Clearly, these plates, being conductive, also could not serve as "transmission windows" for x-rays, as defined by applicants.

In column 25, lines 47-51, Trans states: "Electrode **476** includes an outer conductive plate **480,** an electrosorptive bed **482** and a polymer coating **483.** Conductive plate **480** is *connected to the negative pole of a D.C. power source,*" and in column 26,

lines 9-13: "Electrode **477** includes an outer conductive plate 485, an electrosorptive bed **487** and a polymer coating **489**. Conductive plate **485** is *connected to the negative pole of a D.C. power source*, and is generally similar in design and construction to conductive plate **480**." These plates, being conductive, also could not serve as "transmission windows" for x-rays as defined by applicants, and in fact by virtue of their conductivity are used to deliver the voltage differential between the two electrodes.

Significantly, in column 28, lines 57-61, Trans states: "Double-sided electrodes are made by gluing two sheets of the carbon aerogel composite to both sides of a *titanium (or other equivalent metal-containing) plate* that serves as both a current collector and a structural support." Here, we see an express statement preferring titanium or equivalent plates, and it is clear that titanium does not have the necessary material properties to serve as a proper "transmission window" for x-rays, as defined by applicants.

From a different angle, it is also helpful to examine exactly what Tran's electrodes are in "intimate contact" with, so as to determine whether the materials in intimate contact (or any type of contact, since "intimate contact" as defined by applicants also embodies an element of rigidity in relation to flow conditions) with Tran's electrodes may suitably function as "transmission windows" for x-rays. Many statements in Tran - in addition to some of the above excerpts - make clear that *the electrodes are in contact (whether "intimate" or not) with*

conductive, metallic materials which would not properly transmit x-rays.

Thus, in column 9, lines 16-20, Tran states: "Each single-sided electrode **35, 36** includes a single sheet of carbon aerogel composite *bonded to one side of a titanium or functionally equivalent metal-containing sheet with a conductive epoxy or other appropriate bonding material.*" Similarly, in column 9, lines 24-26, Tran states: "Each double-sided electrode, i.e., **37**, includes two sheets of carbon aerogel composite *bonded to both sides of a titanium sheet with conductive epoxy*. In other words, Tran's electrodes are in "intimate contact" with titanium or a similar metal, which is manifestly not a "transmission window" for x-rays as defined by applicants.

Similar statements along exactly the same lines can be found in many other places throughout Tran, including, but not limited to: column 9, lines 36-59; column 13, lines 4-9; column 22, lines 16-31 (talks about importance of the support being "metallized"); column 23, lines 39-43; and column 28, lines 57-61.

In all cases, whereas applicants in claims 4, 5, 64, and 65 set forth a "transmission window in intimate contact with" an electrode, Tran discloses and specifies at length, a *non-transmissive window* bonded, or in some form of contact with, the electrode. Thus, for all of the foregoing reasons, claims 4, 5, 64, and 65 should have been allowed by examiner.

Although claims 4, 5, 64, and 65 were thus allowable as originally filed, applicants have nevertheless chosen to amend these claims to expedite prosecution - without prejudice to

prosecution of any future patent application based on this application - in a manner which makes clear that these transmission windows must transmit x-rays.

Thus, applicants have amended claims 4, 5, 64, and 65 to replace all occurrences of the term "transmission window" with the term "x-*ray* transmission window." All other references to "transmission window" throughout the claims have also been amended to refer to an "x-*ray* transmission window."

Clearly, Tran does not disclose, suggest or motivate any type of "x-ray transmission window in intimate contact with" Tran's electrodes. Any materials existing in Tran's cell which may inadvertently be capable of transmitting x-rays are not fashioned as windows and are not "in intimate contact with" the electrodes. Conversely, all materials in Tran which are "in [intimate or other] contact with" the electrodes do not transmit x-rays.

As a result of the foregoing, claims 4, 5, 64, and 65 add patentable distinctness beyond their allowability based on their dependencies on allowable claims 1 and 62.

It is also pointed out that new claims 124 through 160 are based independently on such an x-ray transmission windows in intimate contact with the electrodes. Applicants respectfully request allowance of these new claims for the reasons set forth above.

13. The geometric configuration of the inflow and outflow path into and out from the cell is also of significance for enabling

an ionic cell to identify and measure the concentration of elements in fluids.

Figure 24, cited by examiner, merely shows the obvious fact that there is an inflow into the cell and an outflow from the cell. This figure illustrates nothing whatsoever about the geometric configuration of the inflow and outflow, slotted, tubular, or otherwise, or the relationship of the inflow and outflow to the interelectrode gap. Nor does the discussion accompanying Figure 24 say anything about this.

Although Tran discloses nothing suggestive of a slot, applicants' claims 7, 12, 67 and 72 are nevertheless amended, to expedite prosecution without prejudice to future prosecutions based on the present case, to recite that these inlet and outlet flow slots are "substantially coplanar with said central flow interelectrode gap," as specified in paragraph 66 of applicants' disclosure.

One of the benefits of this coplanar configuration is that by the time the fluid enters into the interelectrode gap, the fluid is uniformly dispersed within the slot and so will flow smoothly into the interelectrode gap and lend itself to uniformity of extraction. For a removal cell such as Tran's, it does not matter whether the extraction is uniform, because measurement is not an issue. However, when measuring *concentration*, which is applicants' goal, it is helpful to introduce the fluid into the interelectrode gap with some degree of uniformity, as this boosts the accuracy of the resulting measurements. In this way, the inlet and outlet flow slots are

essentially geometric extensions of the interelectrode gap in terms of their impact on flow, and this enhances accuracy of identification and measurement.

Tran does not in any way disclose, suggest, or motivate this coplanar alignment, and as such, claims 7, 12, 67 and 72 add further points of patentable distinctness beyond merely their dependence on allowable claims.

14. Figure 27, cited by examiner, shows the interelectrode gap itself configured as a tube with circular cross section. Figure 10, also cited by examiner, merely represents in block diagram form, a system with a plurality of cells. Applicants suppose that examiner is interpreting Figure 10 to depict a plurality of Figure 27-type cells, and thus is taking these two Figures, in combination, to suggest a "plurality flow tubes."

First, this combining of Figures 10 and 27 stretches Tran beyond anything disclosed or suggested. Second, the tubular cell of Figure 27 is in no way related to the *inlet* or *outlet* flow tubes disclosed and claimed by applicants. In Figure 27, it is the *cell itself* which is configured as a tube, not the inlets or outlets.

Although Tran discloses nothing suggestive of applicants' plurality of inlet and outlet flow tubes, claims 8, 13, 68 and 73 are nevertheless amended, to expedite prosecution without prejudice to future prosecutions based on the present case, to specify that the inlet and outlet flow tubes are "substantially coplanar with said central flow interelectrode gap and

substantially parallel with one another," as specified in paragraph 172 of applicants' disclosure.

The benefits of this configuration are similar to those of the inlet and outlet flow slots just discussed in reply to point 13. The inlet and outlet flow tubes are essentially geometric extensions of the interelectrode gap in terms of their impact on flow, which aids in uniformity of extraction, and thus, increases measurement accuracy.

Claims 8, 13, 68 and 73 thus recite another of applicants' novel and nonobvious means and methods for enabling the practical implementation of a cell for identifying and detecting elements in fluids, and add patentable distinctness beyond their dependence on other allowable claims.

15. Yet another of applicants' novel and nonobvious teachings relates to introducing turbulence during inflow (but not in the interelectrode gap).

Element 608 in Figure 28, cited by examiner, is described by Tran, column 32, lines 32-36, as follows: "The first plate **603** includes a serpentine trough **607**, and the second plate **605** includes a similar serpentine trough **608**, such that when both plates **603**, **605** are connected together, troughs **607**, **608** and part of insulation layer **606** form channel **601**, which *defines a serpentine pathway.*" Further, at column 32, lines 25-28: "serpentine channel **601** . . . is made as narrow but *as long as possible, providing a long flow path in a small space* . . ." In sum, the purpose of this serpentine pathway (which examiner

interprets as "turbulence enhancement means"), is to provide a long flow path in a small space, which is ideal when one is looking to *remove* ions from a solution, but which has no pertinence at all to *identifying elements or measuring concentration*. Indeed, for measurement, applicants provide a single, rather small cell, and remove only a small percentage of the ions.

Applicants are working on the supposition that examiner believes that Tran's serpentine pathway might introduce some degree of turbulence into the fluid flow even if that is not Tran's intention. Applicants' claim 9, however, specifies "*inlet flow means* [not the cell channel itself] comprising turbulence enhancement means," while claim 69 specifies "enhancing a turbulence of the flow of said fluid *while entering said fluid.*"

As specified in paragraph 174 of applicants' disclosure, applicants enhance inflow turbulence for "inducing mixing of the flow stream to allow the impurities to be more uniformly extracted from the flow stream passing through the concentration cell." Similarly, as noted in reply to points 13 and 14 above, it is desirable to provide a uniform flow through the interelectrode gap itself, so as to boost the accuracy of measurement.

Where points 13, 14 and 15 all come together, is in the fact that applicants enhance turbulence to stir up the fluids *during inflow* to mix impurities as uniformly as possible in the fluid entering the cell. Then, applicants ensure that the now-mixed fluid enters the cell as uniformly and smoothly as possible so

that the measurement is as accurate as possible. Thus, turbulence is desirable *before* the fluid enters the interelectrode gap to promote uniform mixing, whereas uniformity of fluid flow past the electrode plates is desirable once the fluid has entered the interelectrode gap.

Tran does not disclose, suggest or motivate *inlet flow means* comprising turbulence enhancers or enhancing turbulence *while entering the fluid* into the cell. Any turbulence which may inadvertently and accidentally be caused by Tran's serpentine path occurs *within the interelectrode gaps themselves* and not during the inflow, and is not in any way part of Tran's motivation. Such turbulence as may be inadvertently introduced by Tran is not used to induce mixing to enable uniform extraction, and would in fact hinder, not enhance, the measurement accuracy which applicants seek.

While claims 9 and 69 thus carry patentable weight beyond their dependencies on claims 1 and 62, even without amendment, applicants have nevertheless amended these claims to make clear that this turbulence is used to "induce mixing of said flow to enable *uniform extraction* of said at least one element from the flow stream" (claim 9, similar amendment for claim 69). This amendment is made to expedite prosecution without prejudice to prosecution of any future patent application based on this application, and it gives even further patentable distinctness to claims 9 and 69.

16. At column 18, lines 21-30, cited by examiner, Tran states:

"In the event the electrodes become saturated with organic contaminants, it is possible to clean and regenerate the carbon composite electrode **44**, or other porous monolithic electrodes by passing solutions of chemically and electrochemically regenerated oxidants, including but not limited to Ag(II), Co(III), Fe(III), ozone, hydrogen peroxide, and various bleaches such as ClO^-, through the electrochemical cell **30**. Other effective regenerant solution components include organic acids, surfactants, and chelating agents." Examiner appears to interpret these various chemical as "debris cleaning means."

Claims 10, 14 contain patentable weight even without amendment, because Tran's inlet flow means do not *comprise* these chemical agents. These chemical agents are independent substances merely passed through the cell.

Nevertheless, to expedite prosecution without prejudice to prosecution of any future patent applications based on this application, applicants have chosen to amend claims 10 and 14 to specify "said inlet flow means comprising *access means for accessing said inlet flow means* for cleaning debris therefrom," based on paragraph 173 of applicants' disclosure. Claims 70 and 74 are similarly amended.

Because Tran does not disclose or suggest any means for gaining such physical access to the inlet or outlet flow means, but only discloses flowing chemicals through the cell, this amendment further strengthens to patentable distinctness of these claims, beyond the dependency of these claims on other allowable claims.

17. The constitution and overall function of the cell body is also an important consideration in the practical design of a cell suitable for element identification and concentration measurement, in contrast to the removal taught by Tran.

Regarding elements 546-549 cited by examiner, Trans states at column 32, lines 9-12: "Four electrodes **540-543** . . . are bonded to the inner surface of a vessel **545**, and are separated by four suitable insulation dividers **546-549**." Examiner appears to interpret Tran's cell as comprising a "body" which in turn comprises these "four suitable insulation dividers **546-549**." Of course, these insulation dividers - as insulators - by definition will comprise "substantially no conductivity." However, Examiner goes on to assert - without comment or support - that these insulation dividers will also resist ionic leaching and radiation degradation.

We shall assume - strictly for the sake of argument - that Tran's insulation dividers 546-549 happen also to be made from a material which resists ionic leaching and radiation degradation, however inadvertent this may be. Again, there is no support for this assumption, but we shall make this assumption nevertheless for the sake of argument. With this assumption, the question now becomes one of giving more detailed definition to applicants' "cell collector body."

Applicants' cell collector body is discussed primarily in paragraphs 64, 67 and 68 of applicants' disclosure. Paragraph 64 states that "ionic pre-concentration cell *100* comprises a cell

collector body *102* with an inlet flow port *104*, an outlet flow port *106*, an inlet flow slot *108*, an outlet flow slot *110*, an electrode assembly *112* (detailed further in Figs. 3 and 4), and tightening fasteners *109*." Paragraphs 67 and 68 further detail electrode assembly *112* as illustrated in Figures 3 and 4. It is clear from paragraphs 64, 67 and 68 as well as Figures 1-4 that the cell collector body *102* is used to maintain the positions of the upper and lower high surface area electrodes, the upper and lower x-ray transmission windows, and the various inlets and outlets, relative to one another. Applicants' cell collector body thus is more than just "insulation dividers" separating the electrodes as in Tran.

Consequently, applicants have amended claims 15 and 75 to depend upon claims 4 and 64 respectively, thereby making the upper x-ray transmission window an element of these claims. As discussed at length earlier in point 12, Tran does not disclose, suggest or motivate any type of x-ray transmission window in intimate contact with Tran's electrodes.

Further, claims 15 and 75 are amended to specify the cell collector body "maintaining a position of said upper and lower high surface area electrodes and said upper x-ray transmission window relative to one another." This is in no way disclosed, suggested, or motivated by Tran's "insulation dividers." As such, claims 15 and 75 add patentable distinctness of their own accord, in addition to the patentable distinctness of claims 1 and 4, and 62 and 64.

Please note that these amendments are based on assuming that

Tran's "insulation dividers" are made from a material which resists ionic leaching and radiation degradation. However, this is strictly for argument. Thus these amendments are made to expedite prosecution without prejudice to a subsequent prosecution based on this case.

18. Trans states at column 22, lines 13-24: "Electrode **300** includes a substantially flat, thin, corrosion resistant, rectangularly shaped structural support member **302**, which comprises a dielectric board, substrate, or sheet **303**. In one embodiment . . . In another embodiment, dielectric board **303** includes a *fiberglass* epoxy board." Examiner appears to be of the view that structural support member **302** which in "another embodiment" includes "fiberglass" is part of a "cell collector body" and thus reads on applicants' "cell collector body comprising . . . fiberglass" as recited in claims 16 and 76.

Claims 16 and 76 are thus amended similarly to claims 15 and 75 as discussed in point 17 above. First, applicants have amended claims 16 and 76 to depend upon claims 4 and 64 respectively, thereby making the upper x-ray transmission window an element of these claims. Next, these claims are amended to specify the cell collector body "maintaining a position of said upper and lower high surface area electrodes and said upper x-ray transmission window relative to one another." This is in no way disclosed, suggested, or motivated by Tran's fiberglass dielectric board. As such, claims 16 and 76 add patentable distinctness of their own accord, in addition to the patentable

distinctness of claims 1 and 4, and 62 and 64.

19. We turn now to another of the very important novel and nonobvious advances which applicants have made to the art for identifying and detecting concentrations of elements in fluids. This relates to how to optimize the cell for various forms of identification and measurement, and particularly, to how the electrode thicknesses impacts identification and measurement.

Even if Tran discloses an electrode thickness which happens to fall within the range of thicknesses given by $\ell = 1/(\mu * \rho)$ in some circumstances, this is purely accidental and coincidental.

What is clearly novel and nonobvious about this aspect of applicants' disclosure, is that applicants: 1) start off from the premise that these cells will be identifying and measuring concentrations of elements in fluids, rather than merely removing these elements as in Tran; 2) start off from the premise that x-rays (particularly, reading x-ray emissions following x-ray bombardment) will be used for this identifying and measuring; 3) recognize that the physical characteristics of the cell - particularly the thicknesses of the electrodes (and the width of the interelectrode gap, discussed in point 21, below) - should be carefully selected to account for attenuation effects as discussed, for example, in paragraph 75 of applicants' disclosure; 4) recognize that this attenuation will be different for different fluids and different elements; 5) recognize that the thicknesses of the electrodes and the width of the interelectrode gap should therefore be optimized to properly

account for attenuation and therefore should differ depending upon the fluids to be analyzed and / or the elements to be identified and measured; and 6) derive and present formulaic generalization which specify how the thicknesses of the electrodes (and in point 21, the width of the interelectrode gap) ought to be varied in relation to the fluids to be analyzed and / or the elements to be identified and measured, to yield the most accurate identification and measurement in light of attenuation.

Tran does not even come close to disclosing or suggesting or motivating all of these considerations, and in particular, Tran does not in any way touch upon how to select these key cell parameters - the thicknesses of the electrodes and the width of the interelectrode gap - so as to optimize for x-ray attenuation in light of the fluid and elements intended to be tested.

Consequently, applicants have added new method claims 161 through 168 which specifically set forth "[a] *method of optimizing fabrication* of an ionic preconcentration cell for identifying and measuring concentrations of elements in fluids." Claim 161 and its dependents address optimizing the electrode thicknesses to account for the *fluids to be analyzed* and are thus akin to claims 34, 35, 84 and 95. Claim 165 and its dependent address optimizing the electrode thicknesses to account for the *elements to be identified and measured* and are thus akin to claims 18, 19, 78 and 79.

Because Tran does not in any way disclose, suggest, or motivate this method of optimization, applicants respectfully request allowance of claims 161 through 168.

Additionally, applicants have added new product-by-process claims 169 through 176, for "[a]n optimized ionic preconcentration cell product, optimized for identifying and measuring concentrations of elements in fluids . . . produced by a process comprising . . ." a set of steps parallel to those of claims 161 through 168.

Because Tran does not in any way disclose, suggest, or motivate this optimized product produced by this optimization product, applicants also respectfully request allowance of claims 169 through 176.

20. Sizing the electrodes in relation to the x-rays is another significant consideration in the practical design of an identification and measurement cell which is not disclosed, suggested or motivated by Tran's removal cell.

Examiner is stretching Tran beyond recognition by asserting that "Tran et al. would *necessarily* have electrodes having an ordinary surface area approximately equal to an interrogation spot area to which the cell is exposed (col. 33, lines 3-4)."

All Tran says at column 33, lines 3-4, is that "X-ray fluorescence can be used to monitor heavy metals, or like materials, that accumulate on the electrodes." As noted earlier, all Tran discloses is that an electrochemical cell can be used to concentrate dilute ionic solutions for subsequent measurement, and that XRF is among the techniques that that can be used for this measurement. No further detail whatsoever is provided about how to do this. It is applicants, in the case under

consideration, who fill in the many details not provided by Tran about *how* to actually do this in practice.

Tran's cells are for *removal* and so will necessarily be much larger than applicants' cells, which are only for *identification and measurement*. If Tran were to use his cell for measurement by x-ray fluorescence, where, exactly, would he position the x-ray machine (see point 24 below)? Or the detector (also point 24)? Through what x-ray-penetrable transmission window would these x-rays be passed, when Tran has disclosed nothing about any type of x-ray transmission window and has in fact disclosed contacting the outer surfaces of the electrodes with *metals that block, not transmit, x-rays* (see point 12)? How would Tran account for x-ray attenuation (see point 19), which is a very important consideration to ensure accuracy? This needs to be carefully considered, and the bald assertion that cells and be used to preconcentrate ions and then undergo XRF analysis gives no answers.

Tran's cells are quite large. For example, Tran's cell of Figure 3 explicitly illustrates seven flow gaps in succession, but that is only for illustration. It is clear that Tran envisions many more electrode pairs and flow gaps. The flow gaps near the entry of the "feed stream" will naturally pick up more contaminants, and those near the outflow of the "product" will naturally pick up less, since many contaminants will have been removed earlier in the flow. So, where does one target the x-ray machine, or the detectors? Over the entire cell? On a particular spot? If so, on which particular spot? And, what

areas of the cell are to be avoided because they might skew the readings inaccurately? The answers are not in Tran.

If Tran would "necessarily have electrodes having an ordinary surface area approximately equal to an interrogation spot area" as examiner asserts without any support, this seems to suggest that the interrogation spot would cover the whole cell in Tran's Figure 3, since the electrodes exists throughout the cell. And, this suggests that the interrogation spot would cover the whole cell of Figures 10 and 17 and 29 and 34 and 35. This is not a targeted, careful use of x-rays designed to yield accurate identification and highly-sensitive parts-per-billion measurements. This in an indiscriminate use of x-rays where the readings will be much more a function of where the x-rays and the detectors happen to be aimed than a function of what elements are actually in the fluid. The bottom line is that it matters where and how on aims the x-rays, and where and how one reads the XRF emissions, and Tran provides no guidance whatsoever on this matter.

For the spiral of Figures 11A and 11B, how would one match the interrogation spot area to the ordinary surface area of the spiral electrode? How would one address attenuation from the inner part of the spiral? For the cell of Figures 24 and 27, the ordinary surface area of the electrode is a cylinder. How would the spot size match the cylinder? Would one have use an MRI-style machine surrounding the cylinder over a 360 degree arc? Clearly, this would be overkill.

More generally, how would one make sure that the measurement

was truly accurate, and not a random function of where one happened to aim the x-rays? These are all issues that Tran does not even realize are issues, and Tran does not remotely address them. Tran simply asserts that XRF analysis can be used to monitor accumulations on the electrodes, and leaves it fully up to others - such as applicants - to teach the novel and nonobvious devices and methods needed to actually so this. One of the very important considerations to which the answer is not at all apparent based on Tran, is how to strike the cell with x-rays and read the XRF emissions to obtain accurate readings. And, matching the electrode and window surface areas to the interrogation spot area is one significant aspect of this.

It is plainly *not* the case that Tran would "necessarily have electrodes having an ordinary surface area approximately equal to an interrogation spot area." In fact, the question of how to match the interrogation spot to the cell raises many non-trivial questions to which the answers are not at all apparent from Tran, and which fundamentally implicate the design and optimization of any identification and concentration measurement cell. Claims 20, 21, 80 and 81 thus introduce additional points of novelty not at all disclosed, suggested or motivated by Tran, beyond their dependence on other allowable claims.

21. Also important in developing a practical cell for identification and measurement is optimization of the interelectrode gap.

Similarly to the discussion in point 19 above, even if Tran

discloses an interelectrode gap width which happens in some circumstances to fall within the range of thicknesses given by

$$d = \frac{\sigma \Phi}{q\varepsilon}\frac{w_i}{w_f}\frac{A}{n_f CF}\times 100\% \approx 2\times 10^{-9}\frac{\Phi w_i A}{q\varepsilon w_f n_f F}\times 100\% \propto \frac{\Phi A}{\varepsilon F},$$

this is purely accidental and coincidental.

Once again, applicants recognize that the physical characteristics of the cell - particularly the width of the interelectrode gap (and the thicknesses of the electrodes discussed in point 19 above) - should be carefully optimized to account for a wide variety of factors including the fluid and elements of interest the cell is to be used to identify and measure, the voltages to be applied, the intended flow rates, and, importantly, the conductivity approximation:

$$\sigma \approx 2\times 10^{-9} C/\text{Ohm}-\text{cm}$$

which applicants have discovered can be applied to parts-per-billion range measurements, as set out in paragraph 123 and the accompanying discussion. These novel and nonobvious considerations for optimizing the interelectrode gap are not in any way disclosed, suggested or motivated by Tran.

Consequently, applicants have added new method claim 177 which specifically sets forth "[a] *method of optimizing fabrication* of an ionic preconcentration cell for identifying and measuring concentrations of elements in fluids" by optimizing the interelectrode gap according to

$$d = \frac{\sigma \Phi}{q\varepsilon}\frac{w_i}{w_f}\frac{A}{n_f CF}\times 100\% \approx 2\times 10^{-9}\frac{\Phi w_i A}{q\varepsilon w_f n_f F}\times 100\% \propto \frac{\Phi A}{\varepsilon F}.$$

New claim 178, dependent on claim 177, specifies a

particular range of gaps which may emerge from this optimization. Claims 177 and 178 are very much akin to claims 22, 23, 82 and 83.

Because Tran does not in any way disclose, suggest, or motivate this method of optimization, applicants respectfully request allowance of claims 177 and 178.

Additionally, applicants have added new product-by-process claim 179 and its dependent claim 180 for "[a]n optimized ionic preconcentration cell product, optimized for identifying and measuring concentrations of elements in fluids . . . produced by a process comprising . . ." a set of steps parallel to those of claims 177 and 178.

Because Tran does not in any way disclose, suggest, or motivate this optimized product produced by this optimization product, applicants also respectfully request allowance of claims 179 and 180.

Please note also that claim 23 is amended to depend on claim 22 and that claim 83 is amended to depend on claim 82, so that it is clear that the interelectrode gap widths specified in these claims are based on the formula:

$$d = \frac{\sigma \Phi}{q \varepsilon} \frac{w_i}{w_f} \frac{A}{n_f C F} \times 100\% \approx 2 \times 10^{-9} \frac{\Phi w_i A}{q \varepsilon w_f n_f F} \times 100\% \propto \frac{\Phi A}{\varepsilon F},$$

and not merely the result of accident or coincidence.

22. The x-ray transparencies of the electrodes are also important in developing a practical cell for element identification and concentration measurement.

Claims 32 and 92 are amended to recite these electrodes "each comprising a high surface area material in turn comprising: an x-ray transparency greater than approximately 90% for characteristic photon energies from an element of interest for which a fluidic concentration is to be measured."

This particular feature of nano-cellular carbon, derived from allowable claims 28 and 88, is not in any way disclosed or suggested or motivated by Tran. As such, this provides patentable distinctness beyond the dependence of these claims on other allowable claims.

23. Claims 35 and 95 have been completely revamped by amendment, and are discussed earlier in point 19 of this reply.

24. As noted earlier in points 11, 12, 19 and 20, Tran merely discloses that an electrochemical cell can be used to concentrate dilute ionic solutions for subsequent measurement, and that XRF is among the techniques that that can be used for this measurement, and stops right there.

Tran does not in any way disclosure or suggest *how* this is to be done, and as we have discussed, arriving at how to do so requires a number of novel and non-obvious inventive steps.

In point 12, applicants highlighted the importance of establishing x-ray transmission windows in intimate contact with the electrodes to allow proper passage of x-rays into the cell and XRF emissions out of the cell in a way that maximizes signal and minimizes noise. In point 19, applicants pointed out the

importance of optimizing electrode thickness to minimize the adverse effects of attenuation. In point 20, applicants pointed out the importance of matching the interrogation spot to the electrodes and the x-ray transmission windows.

Claim 44 is amended to depend on claim 4 rather than claim 2 and to include the claim 2 limitations therein. Claim 4 is further amended to specify that the x-ray source is "positioned and aligned relative to said upper x-ray transmission window for exposing said preconcentration cell to x-rays *substantially transmitted through said upper x-ray transmission window.*" This takes the next step from point 20, and specifies how to align the x-ray source relative to the cell and its electrodes and windows to ensure an optimal x-ray exposure. This goes well beyond the bald statement by Tran that one can use XRF analysis for measurement, and specifies in further detail *how* to do this effectively. Claims 59, 104 and 129 are similarly amended to recite this positioning of the x-ray source for emitting x-rays "substantially transmitted through said upper x-ray transmission window." In addition, claims 59 and 129 specify positioning and aligning the XRF detector to detect the fluoresced energy "through said upper x-ray transmission window."

Because Tran does not disclose or suggest applicants' configuration of electrodes, x-ray transmission windows and x-ray and XRF detection equipment, which is designed to provide highly-accurate measurement using a preconcentration cell, claims 44, 59, 104, and 199 provide further points of patentability beyond the patentability of the claims upon which they depend.

25. Claims 50 and 110 are unamended.

26. Claims 51 and 111 are amended to specify "leakage current monitoring means for monitoring a *total concentration* of dissolved ions in said upper and lower high surface area electrodes *while said electrodes are not saturated*, by monitoring a leakage current from said cell." This is set forth in paragraph 139 of applicants' disclosure. Claims 52 and 112 continue to depend from claims 51 and 111.

As discussed earlier, the central disclosure in Tran relates to the *removal* of ions from solution, and, since the cells will naturally become saturated at a certain point during removal, it is necessary to detect that saturation and respond accordingly, particularly by ending the removal cycle and initiating a purge or "regeneration" cycle. Thus, various sensors such as conductivity sensor **145** are provided to determine when a predetermined saturation level (referred to in Tran as "targeted breakthrough") has been reached. Saturation is thus a desirable, recurring state in Tran, because when saturated, the cells have removed as much material as possible before they are regenerated.

For applicants' identification and detection cell, the situation is precisely the opposite. As stated at the start of applicants' paragraph 138, "[t]o preserve the accuracy in interpretation of the data, *it is important to avoid saturating the electrode surface.*" Continuing to applicants' paragraph 139, "[t]his saturation [more precisely, the concentration of ions in

the non-saturated state] can be observed by monitoring the leakage current. When the voltage is first applied to the electrodes, the ions in the immediate vicinity of the electrodes will be collected and appear as a measurable current. When these ions in the immediate vicinity are depleted, then the leakage current will gradually drop to an asymptotic value to reflect the rate at which ions in the flow stream can migrate under the effect of the electric field to the electrodes. This asymptotic leakage current, therefore, is a measure of the total concentration of dissolved ions in the matrix, *as long as the electrodes are not saturated.* As the electrode approaches saturation, the leakage current will gradually decrease and eventually vanish. Therefore, by monitoring the leakage current, the state of saturation of the electrodes can be monitored."

Because Tran does not disclose or suggest "monitoring a total concentration of dissolved ions in said upper and lower high surface area electrodes while *said electrodes are not saturated,*" and would have no motivation to do so, claims 51 and 111 provide additional points of patentable distinctness beyond the patentability of the claims upon which they depend.

27. Controlling the *percentage of ions extracted* based on monitoring the leakage currents is a novel and nonobvious advance which would not in any way be motivated for an ionic removal cell such as Tran's.

Claims 53 and 113 are amended similarly to claims 51 and 111 as discussed in point 26, to recite "monitoring a total

concentration of dissolved ions in said upper and lower high surface area electrodes *while said electrodes are not saturated.*" In addition, these claims are amended to specify "adjusting the flow of said fluid through said ionic preconcentration cell *to control a percentage of said ions extracted from said fluid,* based on said monitoring said leakage current."

This is in accord with applicants' disclosure beginning with paragraph 112, which states that "*only a small percentage of each impurity species present [is] extracted,*" and "[t]his is accomplished by *adjusting the flow* rate to assure there is an adequate supply of the impurity ions in the flow stream *to allow only a small percentage to be extracted in passing through the pre-concentration cell.*" This is followed immediately by a detailed exposition of the leakage currents j_i which are employed for this purpose. There is nothing in Tran to disclose, suggest or motivate adjusting the flow rate in response to the leakage current to control the percentage of ions extracted. Tran tries to extract all ions without limit (which makes complete sense for a removal cell), and uses the detection of "targeted breakthrough" to shut down extraction entirely and begin regeneration.

As a result, claims 53 and 113 are patentably distinct beyond their dependency on allowable claims for the same reasons as claims 51 and 111, and further, because of the link they establish between monitoring non-saturated ionic concentration and controlling the flow rate to limit extraction.

28. As in point 27 above, there is no motivation for a removal cell such as Tran's to seek to use element injection or fluid dilution to maintain element concentrations in a fluid within a predetermined range. For Tran, the goal is simply to remove elements so the fluid can become purified.

As amended, applicants' claims 55-57 and 115-117 now clearly recite that injecting or diluting, as practiced by applicants, is use for "maintaining said concentration within a predetermined concentration range" as disclosed in applicants' paragraph 143. This is helpful in producing fluids with certain desired element concentrations "[f]or example, not limitation, . . . for process fluids where a dissolved element is depleted by the process or builds up in the stream and needs to be automatically monitored and adjusted if the concentration falls outside of a specified range of values."

This allows applicants' disclosure to be applied not only to measure very low element concentrations in a fluid, but also to produce fluids with low, predetermined element concentrations within a desired range by either injecting more of the element (thereby raising the concentration) or diluting the fluid (thereby lowering the concentration) in response to detecting "that a concentration of at least one element of interest in said fluid has passed a predetermined threshold concentration," that is, in response to the fluid concentration veering outside of the desired concentration range. No such thing is disclosed, suggested, or motivated by Tran.

Tran, at column 7, lines 3-15, states: "The present systems

and methods allow for more effective *regeneration of the electrodes*. . . . Either influent waste stream (such as raw fluid), deionized water, or other regenerant solutions, preferably having a lower ionic concentration than the influent raw fluid, can be employed for flushing out the desorbed contaminants at such conditions. (Regenerant solutions having a higher ionic concentration than the influent raw fluid can also be employed with success.)"

As this passage reveals, Tran is merely using whatever fluid is at hand (other than, of course, the fluid being purified) to flush out the electrodes during regeneration. There are no controls applied in Tran to maintain the "concentration within a predetermined concentration range" as claimed by applicants. Tran can purify fluids; there is nothing in Tran that enables the production of fluids with elements in certain desired ranges based on detecting concentration and either injecting elements (raising concentration) or diluting the fluid (lowering concentration), as set forth in claims 55-57 and 115-117. As such, these claims, as amended, are patentably distinct for reasons beyond their dependency on allowable claims.

29. The release of extracted ions *back into the media from whence they came* is not only unmotivated for a removal cell such as Tran's, it would totally defeat the purpose of such a cell. The very last thing someone in their right mind would do after removing a large quantity of contaminants from a fluid stream is to flush those ions right back into the same fluid stream.

Claims 58 and 118 are amended to recite means for and the method of releasing the ions from the electrodes "into to said fluid." That is, as disclosed by applicants in paragraph 145, according to these amended claims, "the captured ions are released back into the output fluid flow *842* through the central flow interelectrode gap *222*, *such that they are returned to the media from whence they came.*"

Tran certainly does not disclose or suggest such a release back into the fluid stream from which the ions were extracted, and to do so would entirely defeat Tran's motivation to remove ions thereby resulting in a fluid stream which is free of those ions or contains those ions in significantly-reduced concentration.

Applicants, to the contrary, seek to change the concentration *as little as possible* (see, e.g., paragraph 141), because a more pronounced change in concentration reduces the measurement accuracy.

Thus, as amended, claims 58 and 118 recite additional points of patentable distinction beyond those recited by the claims upon which they depend.

30. Tran, in column 14, lines 35-58, cited by examiner, states: "The *electrical circuit* **112** further includes a control system, as a triggering device *to initiate regeneration*. . . A differential amplifier **126** is connected across a shunt resistor **118**, and is further connected to an analog-to-digital converter **127** and a computer **128**. The shunt resistor 118 is used to measure the

current flowing from the power supply **117** to the cell **30**, for monitoring and control. . . *Integration of the transient current* by computer **128** enables accurate control of the deionization/regeneration cycles. The differential amplifier **126** *amplifies the voltage* across the shunt resistor **118** . . ."

These passages of Tran were discussed at length in point 10, and relate to the specific means by which Tran detects "targeted breakthrough," that is, cell saturation requiring the onset of regeneration. There are electrical measurements to detect that the cell is clogged. These are not XRF measurements designed to identify the elements and their concentrations in the fluid stream.

Claim 60 is amended to clearly specify "x-*ray fluorescence* analysis means for analyzing the detected *x-ray fluoresced energy* and deducing therefrom a *concentration* . . ." and claim 120 is amended to specify "analyzing the detected *x-ray fluoresced* energy and deducing therefrom a *concentration.*" These amendments are made to expedite prosecution without prejudice to future prosecutions based on this case because it was already clear from these claims prior to amendment and from their dependent structure that the analysis is of *XRF* readings, and not of the electrical readings for detecting saturation clearly set out in the examiner-cited passage of Tran.

What Tran discloses in this passage are *electrical* means for *detecting saturation to initiate regeneration*, not "*x-ray fluorescence* analysis means for analyzing the detected *x-ray fluoresced energy* and deducing therefrom a *concentration.*" As

elaborated in point 10, it is one thing to determine that a pipe is clogged (which is what Tran's *detecting saturation* is analogous to) and quite another thing to deduce the identities of the elements causing the clog and *measure their respective concentrations* (which is analogous to what applicants do). Further, it would stretch the cited passage of Tran beyond recognition to assert that this paragraph discloses or suggests *x-ray fluorescence* analyses means, since the plain meaning of this passage clearly and unequivocally relates to electrical measurements to detect saturation.

Consequently, claims 60 and 120 recite additional points of patentable distinction beyond those recited by the claims upon which they depend.

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31. As discussed in paragraphs 146 through 150 and elsewhere, the purpose of applicants' transportable voltage supply to keep the ions entrained in the electrodes during transport. This is another consideration which would be totally unmotivated by and irrelevant to a removal cell such as Tran's. And, it is another one of the many novel and nonobvious considerations which applicants teach for developing a practical identification and concentration measurement cell.

Because of the attenuation effects discussed earlier in connection with point 19 (as well as in applicants' disclosure), the XRF measurements would not be accurate if the ions were allowed to escape from the electrodes into the interelectrode

gap. In this circumstance, it would become necessary to re-entrain the ions, as stated at the end of paragraph 149. To keep the ions trapped in the electrodes where they need to be for an accurate XRF reading, applicants' "electrodes preferably *remain charged* by transportable voltage supply" as set out in paragraph 146, and thus are "used for entrainment maintenance when transport is required" (end of paragraph 150).

In line with these disclosures, claims 2 and 45 are amended to recite "a transportable voltage supply connected across said upper and lower high surface area electrodes for *applying an electrostatic charge* across said electrodes and *thereby maintaining ions* from said at least one element *entrained in said electrodes during transport* of said ionic preconcentration cell." Claims 63 and 105 are similar amended to specify "applying an electrostatic charge across said electrodes and thereby *maintaining ions* from said at least one element *entrained* in said electrodes *during transport*."

The transportable voltage supply in Fajt et al. does not disclose or suggest any type of specialized functionality related to entrainment maintenance during transport, which is the primary purpose of applicants' transportable voltage supply. Fajt's transportable voltage supply is merely for "low cost and high portability" (column 13, lines 36-37, as also pointed out by examiner) and so is no different from any other portable power supply such as a battery or fuel cell used to power a portable device such as a watch, calculator, telephone, etc., at low cost and in a transportable manner. Nor does Tran in any way disclose

or suggest a combination with Fajt using a portable voltage supply for entrainment maintenance, since Tran would have no motivation to keep ions entrained while the cell is transported. All Tran cares about is removing the ions in the first place, and not letting them back into the flow stream.

Consequently, as amended, applicants' claims 3, 45, 63 and 105 recite additional points of patentable distinction beyond those recited by the claims upon which they depend, and overcome the rejection under 35 U.S.C. 103(a).

Additionally, based on the third sentence of paragraph 148 of applicants' disclosure, applicants have added new dependent claims 122, 123, 127 and 145 which specify the transportable voltage supply "embedded into a body of said ionic preconcentration cell."

32. Claims 61 and 121 are amended to recite "downloading and analyzing said test data from said ionic preconcentration cell." These are among the various functions specified toward the end of applicants' paragraph 141.

Any communications links referred to in Moulthrop, Jr. et al. relate to operational control. Since Moulthrop is simply an operational - not or measurement device - there is no data associated with Moulthrop's cell which in any way discloses or suggests or motivates applicants' test data. Similarly, Tran suggests no such combination with Moulthrop.

Consequently, as amended, applicants' claims 61 and 121 recite additional points of patentable distinction beyond those

recited by the claims upon which they depend, and overcome the rejection under 35 U.S.C. 103(a).

Allowable Subject Matter

33-34. Applicants appreciate examiner's indication of allowable subject matter for claims 24, 25, 28-31, 36-43, 46-49, 54, 84, 85, 88-91, 96-103, 106-109, and 114, and notes that all of the issues raised under 35 U.S.C. 112, second paragraph have been addressed, and that all of these claims include the various base and intervening limitations as referred to be examiner. Consequently, applicants respectfully request allowance of these claims at this time.

As set out below, based on this indication of allowability, several of these claims have been replicated as newly-added independent claims.

Newly-added Claims

Newly-added claims 124 and 143 and their dependent claims specify an upper high surface area electrode, a lower high surface area electrode, a central flow interelectrode gap, fluid flow means, and "an upper x-ray transmission window in intimate contact with an upper surface of said upper high surface area electrode." For all of the same reasons cited in reply to office point 12, these claims are allowable, and do not need to rely on claims 1 and 62 to support their allowability.

The dependents of claims 124 and 143 provide further points

of patentable distinction, and replicate a number of the dependents of claims 1 and 62. For example, the further points of patentable distinction introduced by claims 129, 131, 132, 147, 149 and 150 are discussed in point 24. And, indeed, for all of the dependents of claims 124 and 143, these further points of patentable distinction are elaborated throughout the earlier discussion and apply equally in the context of claims 124 and 143.

The allowability of newly-added claims 161 through 176 was discussed earlier in point 19 of this reply.

The allowability of newly-added claims 177 through 180 was discussed earlier in point 21 of this reply.

Newly-added claims 181 through 190 are based, independently, on previously-allowable claims 28 and 88. These claims separate out the various elements which contribute to the previous allowability of claims 28 and 88.

Newly-added claims 191 through 198 are based, independently, on previously-allowable claims 46-49 and 106-109.

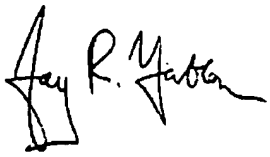
Newly-added claims 199 and 200 are based, independently, on previously-allowable claims 54 and 114.

Conclusion

For the many reasons discussed in this reply, applicants respectfully request allowance of all pending claims. In the event that any issues still remain to be resolved prior to full allowance, applicants again respectfully requests a telephone conference with examiner Chih Cheng G. Kao, following receipt of

this reply, and prior to issuance of any further office action.

Respectfully submitted,



Jay R. Yablon, Registration # 30604
910 Northumberland Drive
Schenectady, New York 12309-2814
Telephone / Fax: (518)377-6737